β−γ Directional Correlation in ^{22}Na

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Motivation

An experiment by the Weak Interactions Group in collaboration with Gammasphere to measure nuclear form factors in the β+ decay of ^{22}Na made good progress in 1996. It has been known for roughly 40 years that for ^{22}Na, the usual allowed approximation for β+ decay does not yield a good estimate of the log ft value, suggesting that higher order corrections from nuclear recoil play a significant role. These higher order terms offer an opportunity to test Standard Model predictions and to search for so-called second class currents. This experiment should also clear up a 2.5σ discrepancy between two past measurements of the β-γ correlation.

Experiment

An effort at the 88" Cyclotron is proceeding to improve the measurement of the directional correlation between the emitted β and the subsequent 1.274 MeV γ from the 2^+ excited state of the ^{22}Ne daughter. The Gammasphere at the 88" Cyclotron is an ideal instrument. Symbiotically, the required precision (about 10^{-4}) of this simple experiment constitutes a stringent test of the Gammasphere array, while using what would otherwise be down time for the array. Our experiment is performed in an off-line configuration, using a 10 μCi ^{22}Na source located at the center of the detector array. A plastic scintillator β detector is inserted in the array for 8% detector solid angle. Events when a Ge detector in Gammasphere fires in coincidence with a β observation are recorded, and we seek a correlation between the β and γ directions of the form $(1 + A\cos^2\theta)$ where θ is the angle between the β detector and the coincident Ge detector, and A is the directional correlation amplitude. In principle, we could count the γ hits in each detector and correlate the Ge detector angular direction to the β detector. However, we address the problem of varying Ge detector efficiency by also counting events when only a γ is detected independently of a β. The number of γ hits in each detector is proportional to the efficiency, so we take a ratio of coincident β-γ events to single γ counts to cancel the efficiencies. This ratio as a function of θ yields the directional correlation.

We took data during the winter holiday shutdowns at the 88" Cyclotron in January of 1996 and in January 1997 with the goal of a statistical uncertainty of 5×10^{-4} in the correlation coefficient A. The earlier run revealed an unexpected systematic difference in count ratios for the two hemispheres of the array at roughly 1.2%, probably due to staggered detector timing delays. This led to an improvement in the cable routing of the array, which has reduced the effect in our raw data to roughly 0.4%. Software timing cuts on the coincident 1.274 MeV γ seem to eliminate this effect to less than 0.1%, and our current analysis in progress seems set to achieve the desired precision (Fig. 1).

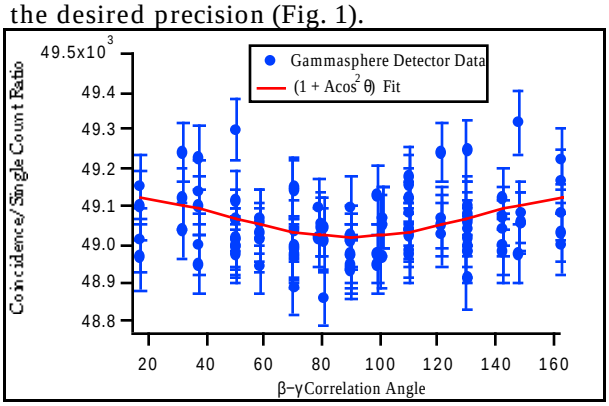

Fig. 1. Jan. 1997 Data, Early Analysis

Recent achievements summarized:

- First β-γ correlation measured with Gammasphere: Nov. 1995, Jan. 1996.
- Cabling upgrade on Gammasphere to improve pretrigger timing staggering
- Jürgen Reich completed Diplomarbeit in summer, 1996 for TU München.
- New 1997 data should complete directional correlation measurement